Africa Partnership Station

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LONG-TERM GOALS

The long-range goals of this research are to assist in the development of the ONR-sponsored Africa Partnership Station to be located in Accra, Ghana, Africa.

OBJECTIVES

1. Develop, prepare, and conduct a video imaging workshop at the University of Ghana. Workshop activities include field and laboratory instruction on modern nearshore processes research utilizing video image processing methods and analysis.

2. Assist in developing skills in making bathymetric measurements in shallow water with GPS and acoustic echosounders.

3. Assist in guiding activities associated with nearshore processes research conducted by the University of Ghana (PI Wiafe) during the second year of their funded program.

APPROACH

The ONR-sponsored project, which is being facilitated by CNE-C6F's Africa Partnership Station (APS) is presently in its second year of development. The overall goals of the program are to assist emerging West African nations in obtaining knowledge of and skills working in shallow coastal environments, developing a remote sensing capability, and creating a partnership where education and capacity building exercises are implemented in the host countries. The program is developing a shallow water component where various researchers from the U.S. and around the world provide in-depth training and expertise in nearshore processes including theoretical knowledge, numerical model development and execution, satellite imagery analysis, and field observation techniques, processing, and assimilation of data with models.

The proposed research builds upon activities conducted in 2008 & 2009, including ONR-sponsored nearshore processes workshops coordinated and carried out by the PI and collaborators (Dr. Dano Roelvink, UNESCO; Dr. George Wiafe and Mr. Selorm Ababio, UG; Dr. Augustus Vogel, U.S. Naval Forces Europe and Africa; Dr. Cheryl Hapke, USGS; Dr. Andrew Ashton, WHOI), and a 3-year ONR-funded proposal to UG (PI Wiafe) to begin development of oceanographic field capabilities within the APS.

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The long-range goals of the Ghana partnership within the APS are to develop a regional observational network of sensors and expertise to support coastal research activities both within the country and extending cross-borders throughout the Gulf of Guinea. The thrust of the program will be coordinated by the University of Ghana in Accra, with laboratory and technical support in the Department of Oceanography and Fisheries, and with long-term plan - through university, governmental, and DOD support - to build, staff, and operate a facility directly on the coastline from which field operations and regional data collection would be based.

The coastal and marine environment of Ghana contributes significantly to the economic development and security of the country. Ghana has demarcated a 200 nautical mile Exclusive Economic Zone (EEZ) within the framework of the United Nations Convention on the Law of the Sea (UNCLOS). This has brought vast living and non-living resources under Ghanaian jurisdiction. Furthermore, shipping traffic continues to rise and associated problems with ballast water and potential oil spill raises concern for ecosystem health. The ability for monitoring the resource and the environment will contribute immensely to the management of the marine ecosystem.

Figure 1. Active erosion at Ada (left bottom), Anyanwi (right bottom), and Accra (top panels) showing the effects of rapid beach erosion threatening major coastal roadways in the region

The coastline of Ghana measures about 550 km and is generally a low-lying area not exceeding 200 m above sea level. It is bordered by a narrow continental shelf extending outwards between 30 and 90 km. Presently, there is an increasing rate of erosion along the coastline. Shoreline recession is caused by the interplay of several factors including prevailing wave regimes, damning of rivers, and removal of vegetative cover. In at least three sites visited during the workshop, the erosion is so rapid that major coastal roadways are being washed into the sea or threatened (Figure 1). Limitations in infrastructure to repair the roadway or use alternative routes (of which there are none presently

constructed) make this a serious problem for local communities and commerce. Understanding the changes to the sediment transport that have occurred at these two sites is critical to forecasting changes along other parts of the coastline, most of which has shown a marked loss of overall sediment within the past 2 decades (Figure 2) based on widely acknowledged anecdotal observations from UG researchers and the local populace.

Figure 2. Rocky coastline along the region just to the west of Ghana (left). This region was characterized by a wide sandy beach just a decade before, similar to adjacent beaches nearby (right)

WORK COMPLETED

In order to facilitate the development of the program, coastal processes workshops were held Accra, Ghana, during 2009. In August of 2009, a week-long training session was conducted by the PI where UG personnel were trained in the use of video, shallow water survey, and integrated GPS systems for nearshore processes field studies. Training was conducted with hands-on experience with new equipment purchased by UG (through DOD-funded research programs), field activities, and classroom instruction. The activities included 2 days of seminars, instruction, and discussion, and 3 days of hands-on instrument training and field activities.

The nature of the daily activities was based on the above discussion with particular emphasis on developing an appropriate capability (*e.g.*, wave prediction, surf forecast, or bathymetric evolution model). The bulk of the effort was devoted to implementing the agenda and preparing presentations, demonstrations and field activities at the workshop.

Central to the workshop was the introduction to expertise and experience in nearshore processes field methods involving shore-based video systems, shallow water sonic altimeters, and GPS positioning devices. Starting from basic concepts, training was arranged to convey in an orderly manner how modern nearshore processes field work is addressed, and how these methods can be utilized in an efficient manner in developing regions where the expertise and experience does not presently exist, but where the interest and relevance is high. The focus was based on the overarching goal that in any observational research program with reaches to the nearshore, it is imperative to measure properties and conditions at the bottom, surface, and lateral boundaries over the appropriate scale of interest (which could range a few hundred meters to many kilometers). This leads to critical observational needs for regional scale field studies supporting numerical modeling and prediction.

The most basic property to measure is the bathymetry. That is, it is important to know the basic properties of the bottom boundary condition, namely its location and how it changes in space and time.

This requires that measurement capabilities be developed to accurately survey the bottom topography from the inner shelf, through the surf zone, and onto the beach face. The instruments of choice are differential-GPS based survey vehicles on land (buggies, dollies, walking) and at sea (personal watercraft and other boats equipped with acoustic altimeters, temperature sensor, and onboard navigation). As part of the workshop, training using a dual-frequency single-beam echosounder integrated with a differential GPS system was done. Activities included operational equipment testing in the field, data collections, and limited post-processing. A test facility was initiated on the UG campus where a shallow water body provides ready access for testing equipment and training.

Large scale changes to the shoreline and nearshore morphology can be monitored with video arrays imaging the beach and surf zone. Although restricted to daylight hours and relatively clear weather conditions, the remote nature of the techniques are attractive in that they are relatively easy to deploy and maintain, and their spatial coverage (of order 1-5 km) can capture a relatively large region of the coastline. Instruction in the preparation of video systems, including laboratory calibration of intrinsic camera parameters was carried out. Deployment strategies were discussed with emphasis on mission planning, data collection, and geometrical image-to-ground quantification of image pixels. Field exercises were carried out locally to familiarize UG collaborators with digital imaging methods and data collection, and then applied to a field situation at a nearby beach with active wave breaking. GPS surveys of ground control points and the beach face topography was included in the exercise.

RESULTS

Training has prepared the UG collaborators to continue development of field programs in Ghana aimed at observing bathymetric and morphological change in nearshore sedimentary environments. Goals for future research were discussed and include 1) establishing a long-term video monitoring site, 2) conducing regular topographic and hydrographic surveys at particular sites, 3) integrating tidal observations from available stations in Ghana, 4) beginning evaluation of grain-size distribution and sedimentary characteristics of selected beaches, 5) including available satellite data into long-term coastal evolution studies, and 6) initializing regional wave models with predicted wave climates for sediment transport modeling studies.

To facilitate UG research efforts within the framework of the APS, improved internet access is required through upgraded infrastructure to UG in general, and in particular to the Dept. of Oceanography and Fisheries. This need has already been identified and some efforts are being put forward to ensure that this happens. Increased bandwidth will facilitate exchange of research results, allow for data mining from global sources, and the timely acquisition of satellite imagery.

Critical equipment needs include a directional wave buoy that would benefit each project outlined above, as well as the entire Gulf of Guinea region as part of the APS. The buoy would allow for wave climatology in the region to be better understood, and to initialize wave models for predicting sediment transport.

IMPACT/APPLICATIONS

The workshop served continue development of capabilities in coastal processes research in West Africa.

TRANSITIONS

Capacity building exercises will continue within the program, including instructional workshops and development of observational capabilities for shelf and surf zone processes.

RELATED PROJECTS

Ongoing partnership with other U. S. Naval and oceanographic entities in the US (UNH, WHOI, USGS, RSMAS, NPS), Ghana (Univ. Ghana), Europe (UNESCO), and in neighboring regions.

REFERENCES

PUBLICATIONS

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